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Hua

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(54) **INDUSTRIAL VEHICLE, SYSTEM FOR MANAGING STATE OF AMOUNT OF ELECTROLYTE OF INDUSTRIAL VEHICLE, AND ELECTRIC FORKLIFT**

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B66F 9/24 (2006.01)

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(52) **U.S. Cl.**

CPC ***B60L 11/1861*** (2013.01); ***B60L 1/003*** (2013.01); ***B60L 3/0046*** (2013.01); ***B60L 11/1877*** (2013.01); ***B66F 9/07572*** (2013.01);

(Continued)

(58) **Field of Classification Search**

CPC ... B60L 2200/44; G07C 5/008; G07C 5/085; G07C 5/0858; G08G 1/20; G01S 5/0027

USPC 701/32.3

See application file for complete search history.

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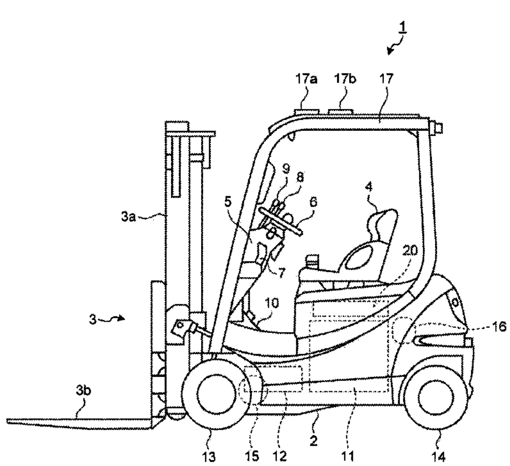
(57) **ABSTRACT**

An industrial vehicle includes a battery that includes battery cells including a battery liquid and connected in series, an battery liquid shortage detection unit detecting a shortage of the battery liquid by detecting a voltage value between the battery cells, an battery liquid-shortage time calculation unit calculating a battery liquid-shortage time, which is a cumulative time of the shortage of the electrolyte detected by the battery liquid shortage detection unit, a memory storing the battery liquid-shortage time calculated by the battery liquid-shortage time calculation unit, and a communication controller attaching time information to the battery liquid-shortage time stored in the memory and outputting the battery liquid-shortage time with the time information to a management server, at a predetermined timing.

17 Claims, 8 Drawing Sheets



(51) **Int. Cl.**

B60L 1/00	(2006.01)
B60L 3/00	(2006.01)
H01M 10/48	(2006.01)
B66F 9/075	(2006.01)

(52) **U.S. Cl.**

CPC ***B66F 9/24*** (2013.01); ***H01M 10/484*** (2013.01); *B60L 2200/42* (2013.01); *B60L 2240/547* (2013.01); *B60L 2240/622* (2013.01); *B60L 2240/70* (2013.01); *B60L 2240/80* (2013.01); *B60L 2250/20* (2013.01); *Y02T 10/7005* (2013.01); *Y02T 10/705* (2013.01); *Y02T 10/7291* (2013.01); *Y02T 90/16* (2013.01); *Y02T 90/162* (2013.01)

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FIG.1

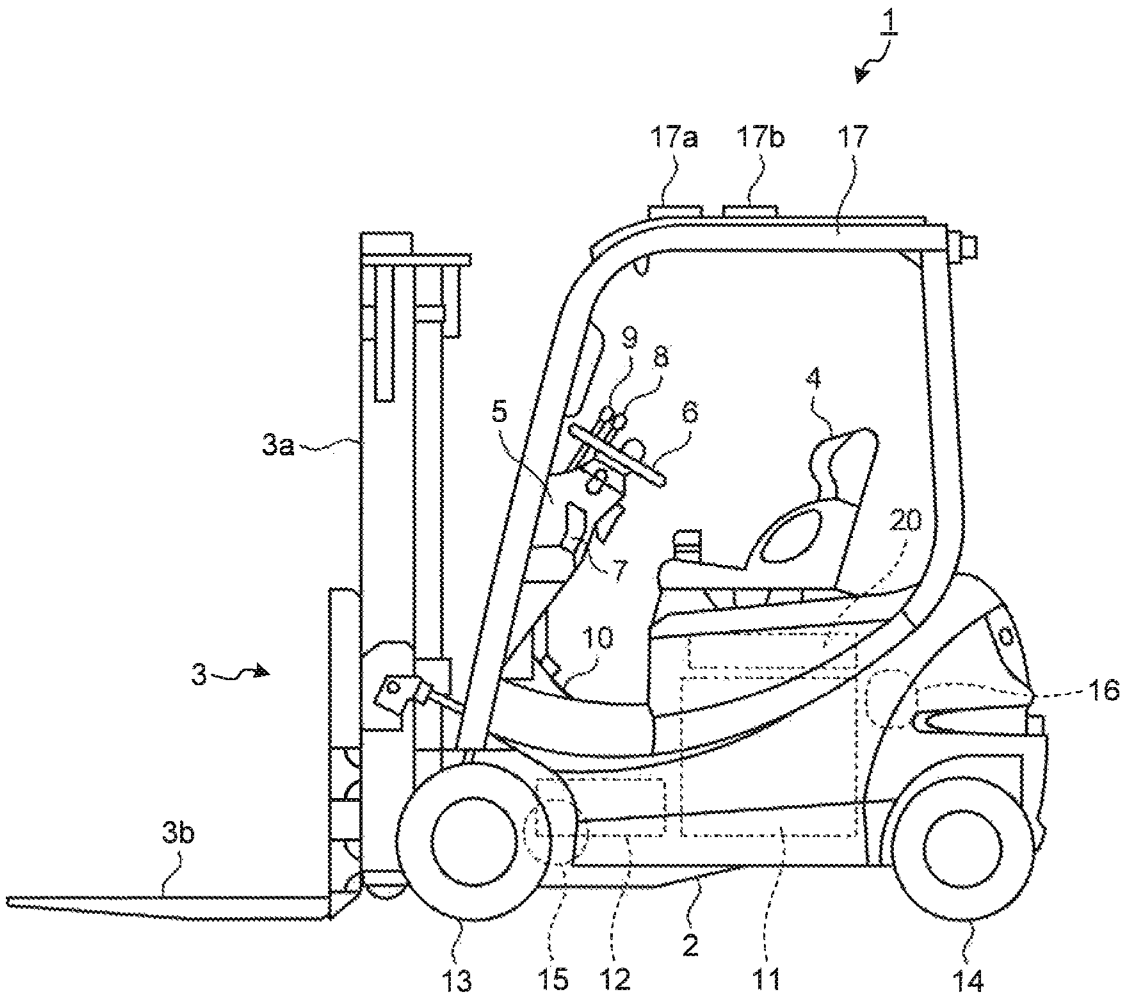


FIG.2

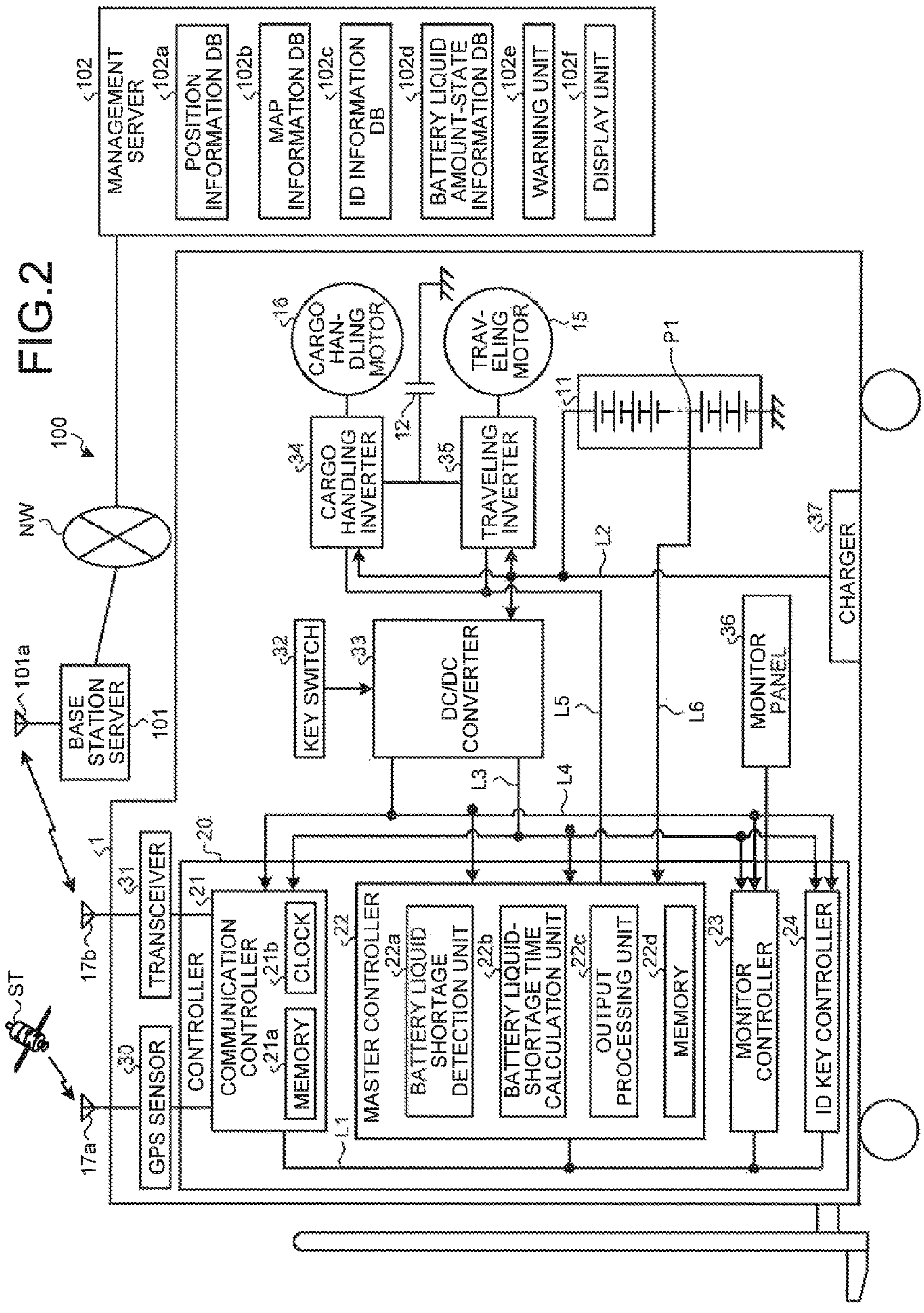

100
NW
MANAGEMENT SERVER
102
POSITION INFORMATION DB
102a
MAP INFORMATION DB
102b
ID INFORMATION DB
102c
BATTERY LIQUID AMOUNT-STATE INFORMATION DB
102d
WARNING UNIT
102e
DISPLAY UNIT
102f
BASE STATION SERVER
101
101a
ST
17a
17b
1
GPS SENSOR
30
TRANSCEIVER
31
CONTROLLER
20
COMMUNICATION CONTROLLER
21
MEMORY
21a
CLOCK
21b
MASTER CONTROLLER
22
BATTERY LIQUID SHORTAGE DETECTION UNIT
22a
BATTERY LIQUID-SHORTAGE TIME CALCULATION UNIT
22b
OUTPUT PROCESSING UNIT
22c
MEMORY
22d
MONITOR CONTROLLER
23
ID KEY CONTROLLER
24
L1
KEY SWITCH
32
DC/DC CONVERTER
33
L3
L4
L5
L6
MONITOR PANEL
36
CHARGER
37
L2
CARGO HANDLING INVERTER
34
TRAVELING INVERTER
35
12
CARGO HAN-DLING MOTOR
16
TRAV-ELING MOTOR
15
11
P1

FIG.3

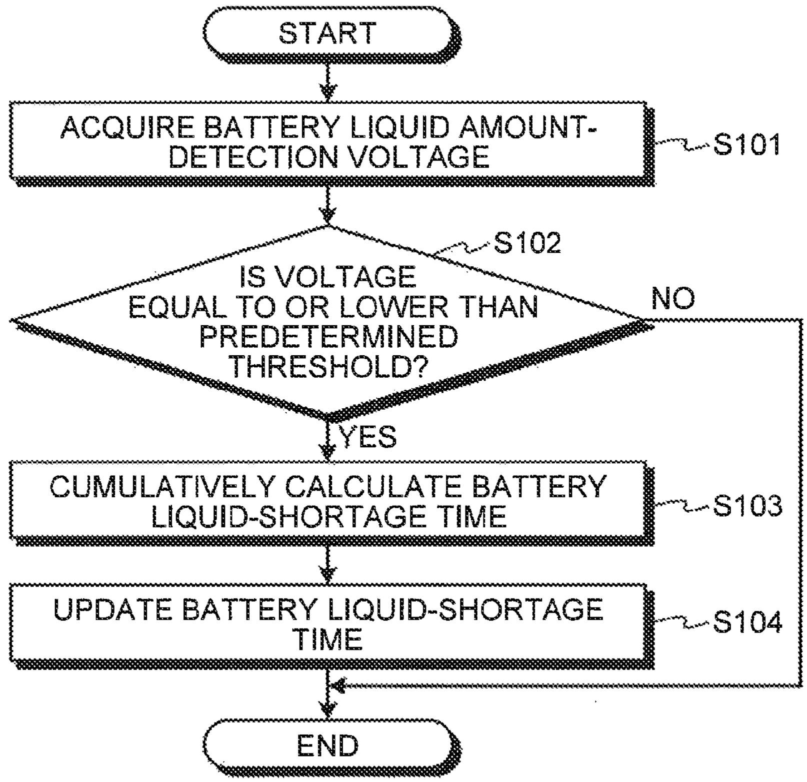

START
ACQUIRE BATTERY LIQUID AMOUNT-DETECTION VOLTAGE
S101
S102
IS VOLTAGE EQUAL TO OR LOWER THAN PREDETERMINED THRESHOLD?
NO
YES
CUMULATIVELY CALCULATE BATTERY LIQUID-SHORTAGE TIME
S103
UPDATE BATTERY LIQUID-SHORTAGE TIME
S104
END

FIG.4

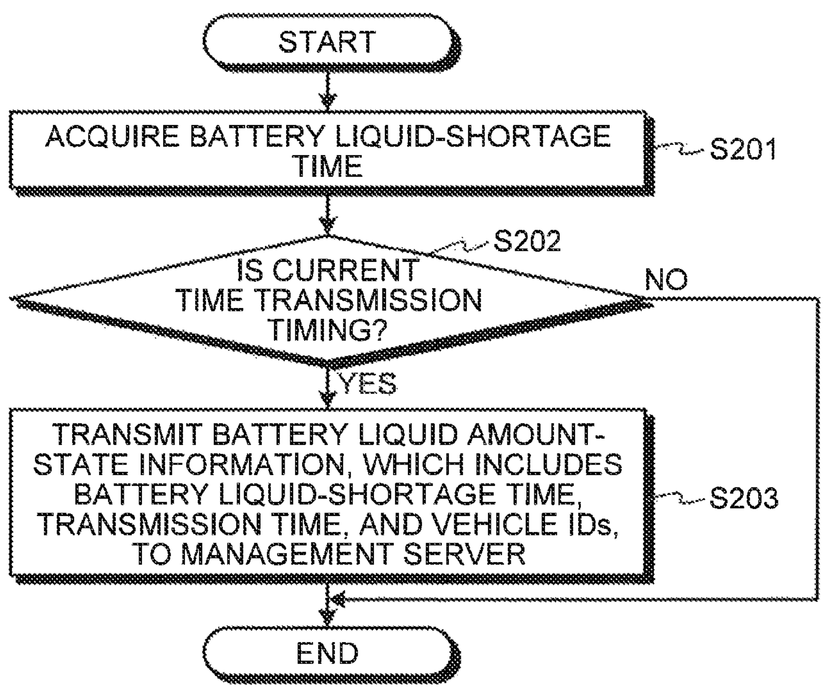

START
ACQUIRE BATTERY LIQUID-SHORTAGE TIME
S201
S202
IS CURRENT TIME TRANSMISSION TIMING?
NO
YES
TRANSMIT BATTERY LIQUID AMOUNT-STATE INFORMATION, WHICH INCLUDES BATTERY LIQUID-SHORTAGE TIME, TRANSMISSION TIME, AND VEHICLE IDs, TO MANAGEMENT SERVER
S203
END

FIG.5

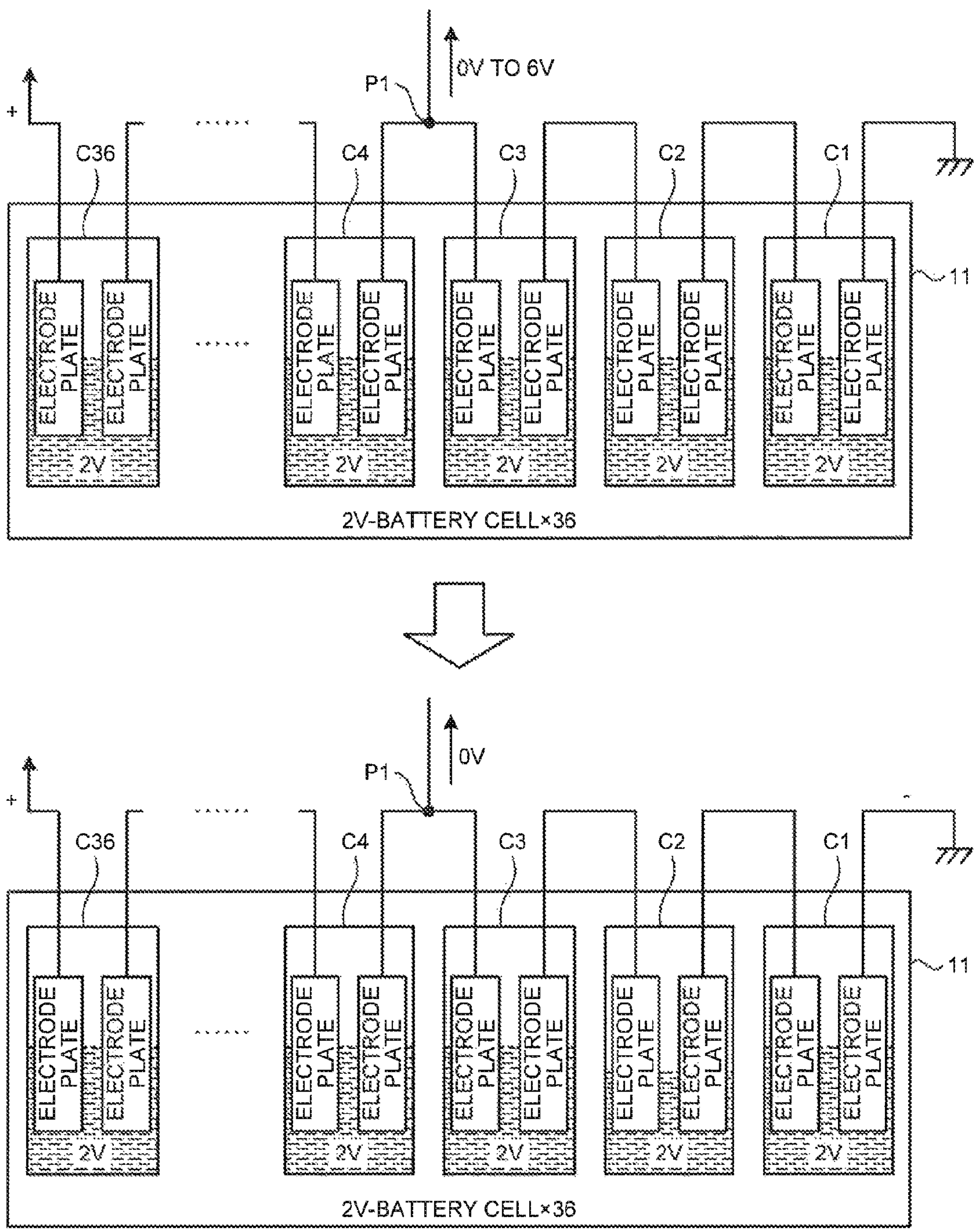
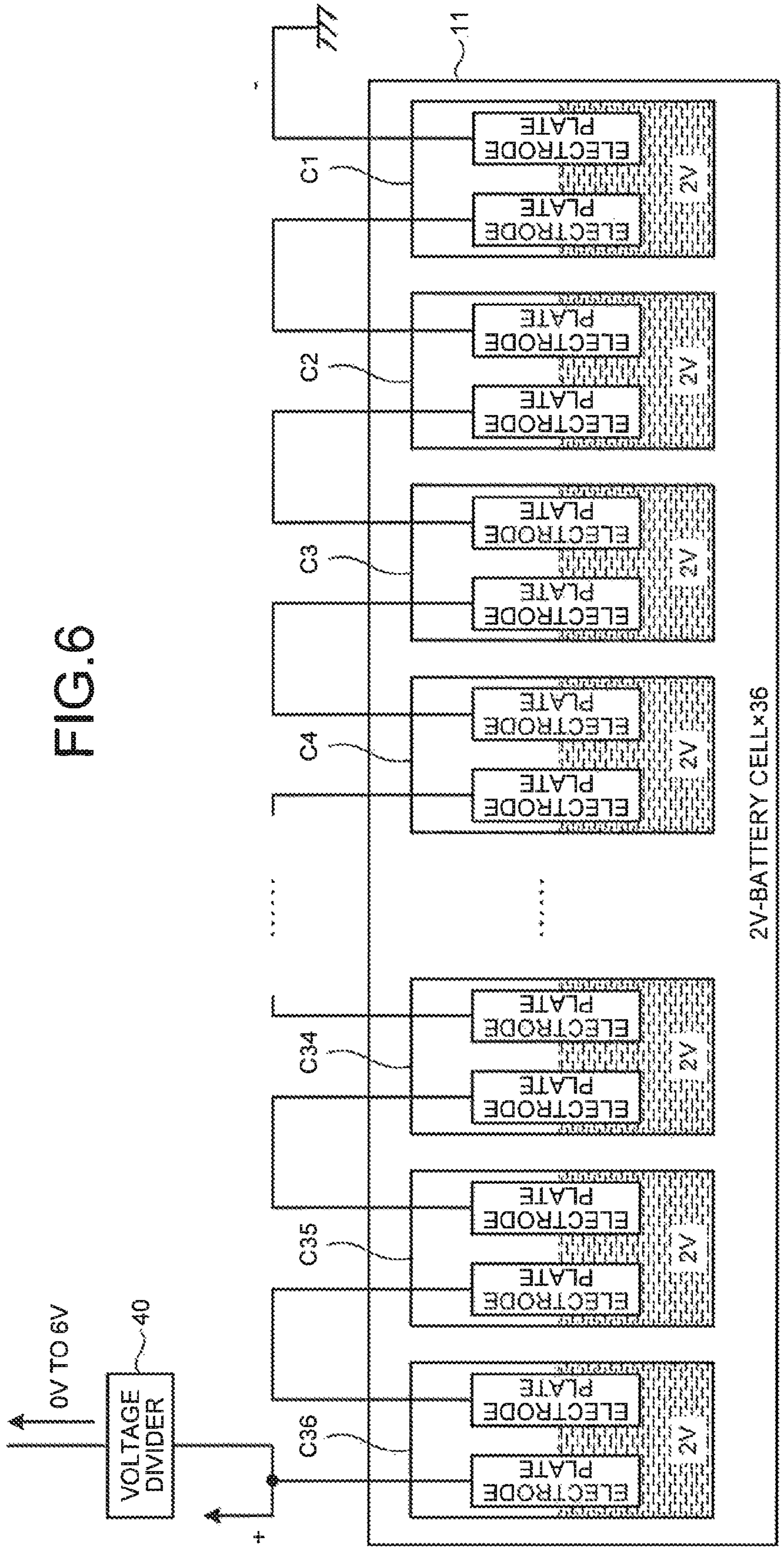

0V TO 6V
P1
+
C36
C4
C3
C2
C1
11
ELECTRODE PLATE
2V
2V-BATTERY CELL×36
0V
P1
+
C36
C4
C3
C2
C1
11
ELECTRODE PLATE
2V
2V-BATTERY CELL×36

FIG.6



11
C1
C2
C3
C4
C34
C35
C36
ELECTRODE PLATE
2V
2V-BATTERY CELL×36
VOLTAGE DIVIDER
40
0V TO 6V
+

FIG.7

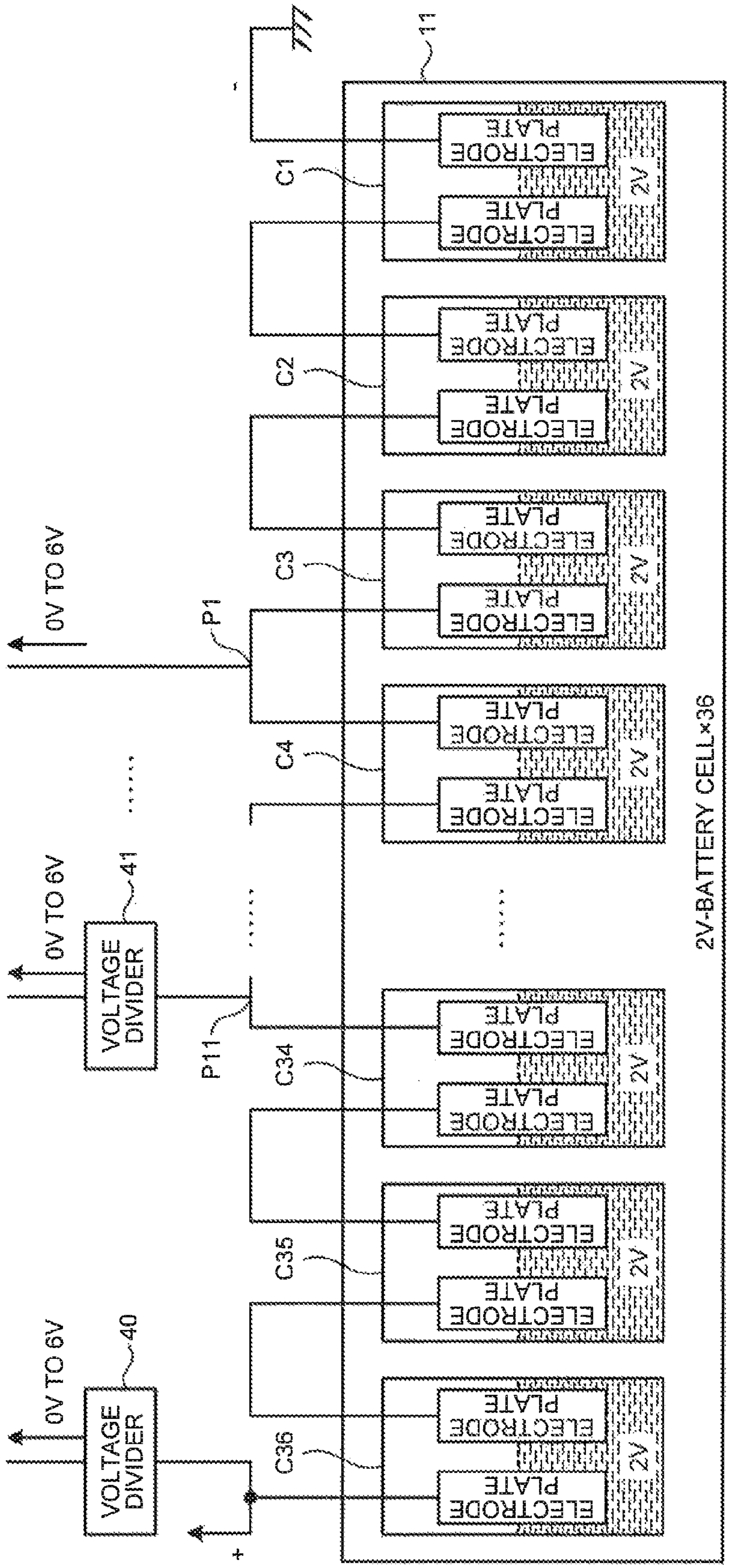

11
C1
C2
C3
C4
C34
C35
C36
ELECTRODE PLATE
2V
P1
P11
0V TO 6V
0V TO 6V
0V TO 6V
VOLTAGE DIVIDER
41
VOLTAGE DIVIDER
40
2V-BATTERY CELL×36
+
-

FIG.8

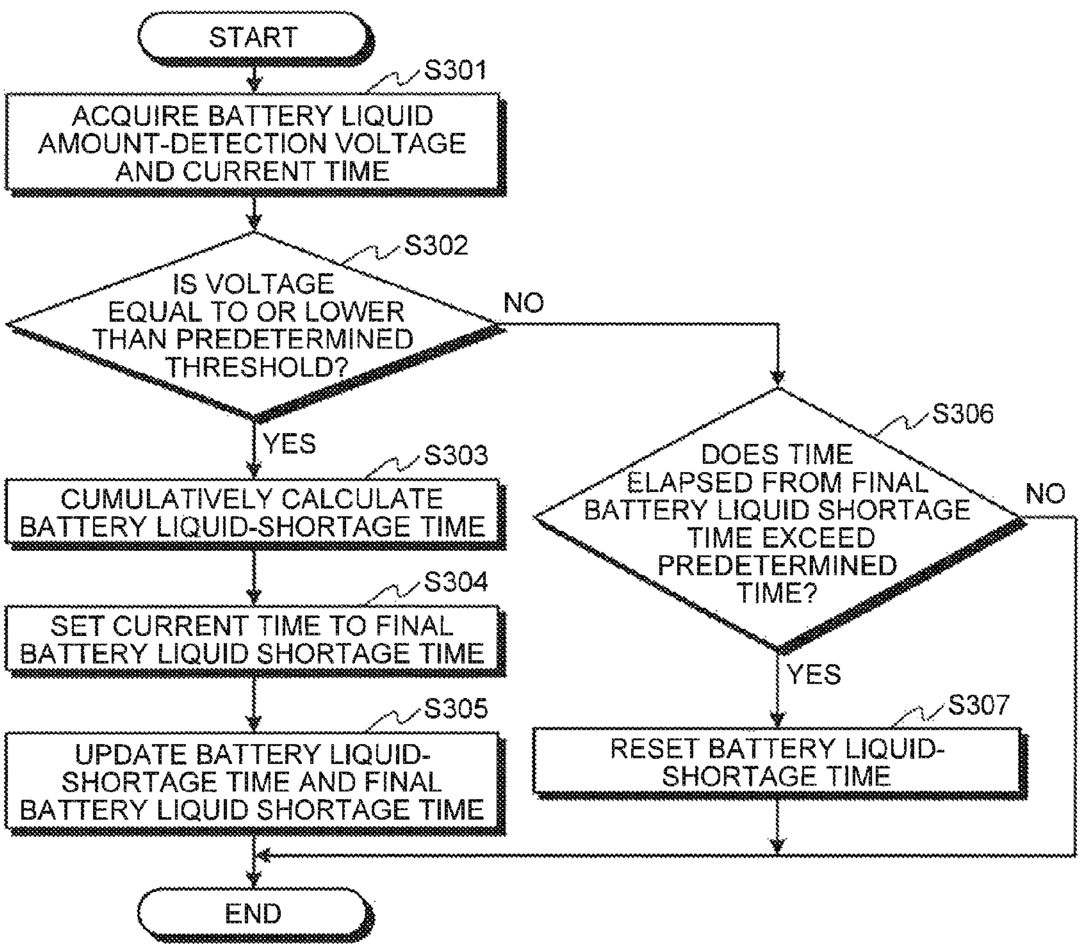

START
S301
ACQUIRE BATTERY LIQUID AMOUNT-DETECTION VOLTAGE AND CURRENT TIME
S302
IS VOLTAGE EQUAL TO OR LOWER THAN PREDETERMINED THRESHOLD?
NO
YES
S303
CUMULATIVELY CALCULATE BATTERY LIQUID-SHORTAGE TIME
S304
SET CURRENT TIME TO FINAL BATTERY LIQUID SHORTAGE TIME
S305
UPDATE BATTERY LIQUID-SHORTAGE TIME AND FINAL BATTERY LIQUID SHORTAGE TIME
S306
DOES TIME ELAPSED FROM FINAL BATTERY LIQUID SHORTAGE TIME EXCEED PREDETERMINED TIME?
NO
YES
S307
RESET BATTERY LIQUID-SHORTAGE TIME
END

FIG.9

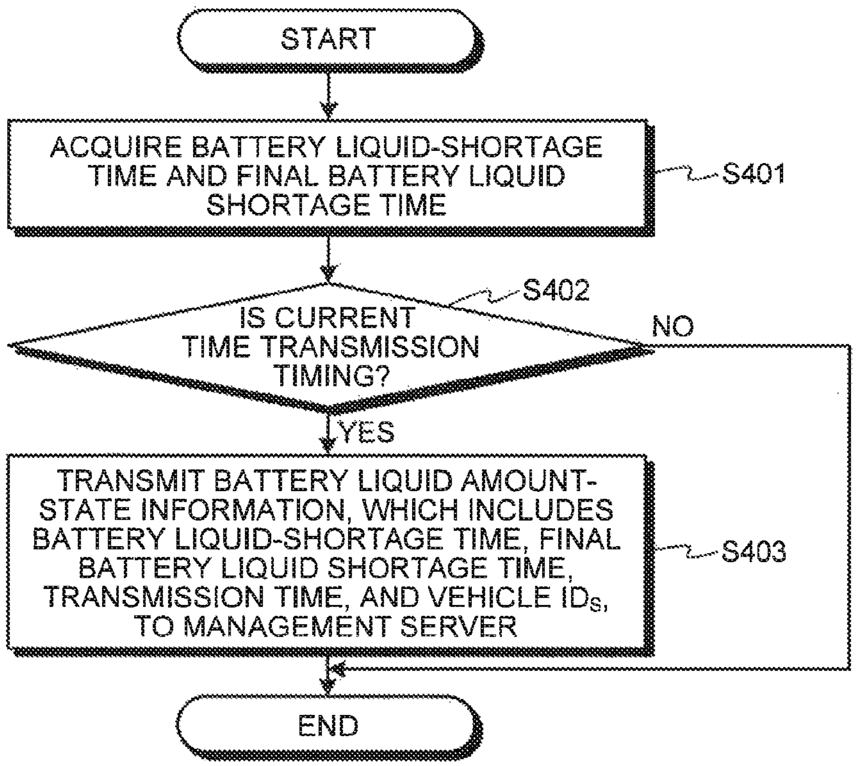
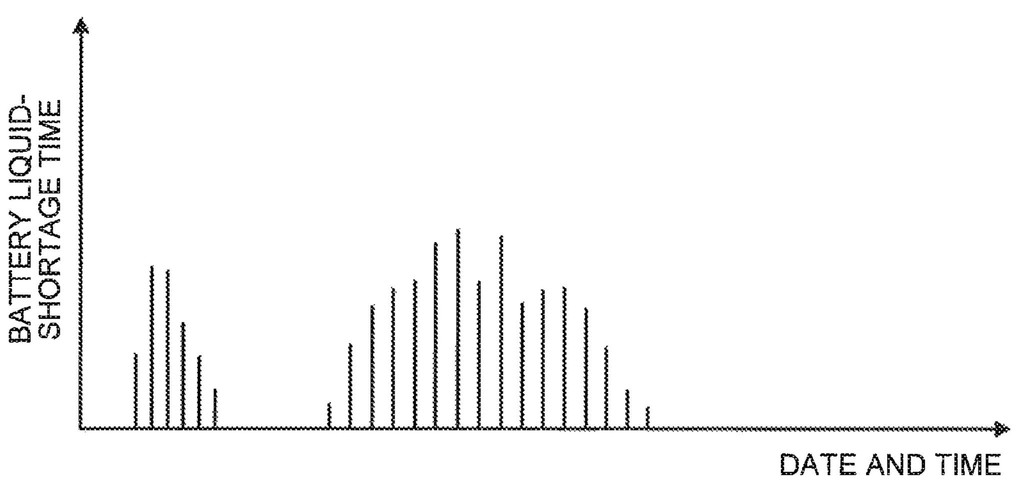

START
ACQUIRE BATTERY LIQUID-SHORTAGE TIME AND FINAL BATTERY LIQUID SHORTAGE TIME
S401
IS CURRENT TIME TRANSMISSION TIMING?
S402
NO
YES
TRANSMIT BATTERY LIQUID AMOUNT-STATE INFORMATION, WHICH INCLUDES BATTERY LIQUID-SHORTAGE TIME, FINAL BATTERY LIQUID SHORTAGE TIME, TRANSMISSION TIME, AND VEHICLE IDs, TO MANAGEMENT SERVER
S403
END

FIG.10


BATTERY LIQUID-SHORTAGE TIME
DATE AND TIME

INDUSTRIAL VEHICLE, SYSTEM FOR MANAGING STATE OF AMOUNT OF ELECTROLYTE OF INDUSTRIAL VEHICLE, AND ELECTRIC FORKLIFT

FIELD

The present invention relates to an industrial vehicle of which the shortage of a battery liquid can be easily detected and the shortage state of a battery liquid can be easily managed, a system for managing the state of the amount of electrolyte of the industrial vehicle, and an electric forklift.

BACKGROUND

An industrial vehicle such as a forklift is provided with a battery. In particular, an electric forklift (hereinafter, a battery forklift) travels by driving a traveling motor using the battery as a power source, and performs a cargo handling operation by operating a cargo handling device through the driving of a cargo handling motor. Here, when the battery is a lead storage battery, the amount of a battery liquid (electrolyte) of the battery is decreased due to the frequent repetition of the charge and discharge of the battery or the like. If the battery is discharged when the amount of the battery liquid is decreased, the degradation of the battery is facilitated. For this reason, there is a concern that the life of the battery is shortened.

In general, when batteries are connected to each other in series, charging is also performed in series. Here, if the capacity of any one of the batteries is insufficient, the amount of charge is increased so that the battery of which the capacity is insufficient is fully charged. For this reason, the other batteries of which the capacity is not insufficient are overcharged. Overcharge causes the life of the battery to be shortened.

In particular, there is a case in which the amount of a battery liquid present in the battery is decreased by electrolysis even though natural evaporation does not occur. When electrode plates of the battery are exposed to the outside due to the shortage of the battery liquid, the degradation of the electrode plates is facilitated by oxidation. As a result, the battery reaches damage. For this reason, when the battery liquid is insufficient, the battery is to be refilled with a battery replenisher.

Accordingly, Patent Literature 1 discloses an industrial vehicle that suppresses the degradation of a battery caused by discharge when the level of the battery liquid is lowered and makes an operator reliably recognize a low battery liquid level state. In particular, Patent Literature 1 discloses an industrial vehicle that stepwise limits the torque of a traveling motor according to an operating time in a low liquid level state.

Further, Patent Literature 2 discloses an industrial vehicle that is provided with a hydrogen gas-concentration sensor near a battery and prevents explosion in advance, which is caused by a hydrogen gas generated during the charge, on the basis of the hydrogen gas-concentration detected by the hydrogen gas-concentration sensor.

Furthermore, Patent Literature 3 discloses a vehicle that detects the shortage of a battery liquid by a liquid level sensor and stores a detection result as data After that, the data are processed by a computer for data processing.

CITATION LIST

Patent Literature

Patent Literature 1: Japanese Patent Application Laid-open No. 2012-100379

Patent Literature 2: Japanese Patent Application Laid-open. No. 2003-009402

Patent Literature 3: Japanese Patent Application Laid-open No. 2002-120999

SUMMARY

Technical Problem

Incidentally, the number of industrial vehicles, which are managed from a remote location through a communication system, has increased in recent years. Meanwhile, the above-mentioned shortage of the battery liquid in the related art can be managed for an individual vehicle.

Here, when the shortage of the battery liquid of each industrial vehicle, which is managed from a remote location, is managed for each industrial vehicle, there is a case in which an operator operating the industrial vehicle or a serviceman performing maintenance neglects the management of the shortage of the battery liquid. If the management of the shortage of the battery liquid is neglected, there is a problem in that the life of the battery of the industrial vehicle is shortened. In particular, since the battery of a battery forklift is frequently charged and discharged and the battery forklift is driven by the battery as a power source, the shortening of the life of the battery causes a trouble in a cargo handling operation. Here, it is required that the states of the shortage of the battery liquid of all of the industrial vehicles, which are managed from a remote location, are managed and the states of the shortage of the battery liquid can be easily and quickly detected. Further, it is also required that the shortage of the battery liquid of a plurality of industrial vehicles can be easily managed.

Meanwhile, if each battery is provided with a liquid level sensor such as a float sensor that detects the shortage of the battery liquid, the structure of the battery becomes complicated and the generalization of the battery is hindered.

The invention has been made in consideration of the above-mentioned problems, and an object of the invention is to provide an industrial vehicle of which the shortage of a battery liquid is easily detected and the shortage state of the battery liquid can be easily managed, a system for managing the state of the amount of electrolyte of the industrial vehicle, and an electric forklift.

Solution to Problem

To overcome the problems and achieve the object, according to the present invention, an industrial vehicle comprises: a storage battery that includes a plurality of battery cells including electrolyte and connected in series; an electrolyte shortage detection unit that detects a shortage of the electrolyte by detecting a voltage value between the plurality of battery cells; an electrolyte shortage time calculation unit that calculates an electrolyte-shortage time, which is a cumulative time of the shortage of the electrolyte detected by the electrolyte shortage detection unit; a memory unit that stores the electrolyte-shortage time calculated by the electrolyte-shortage time calculation unit; a time information generating unit that generates time information; and an output processing unit that performs output processing for attaching the time information to the electrolyte-shortage time stored in the memory unit and outputting the electrolyte-shortage time with the time information to an output unit, at a predetermined timing.

According to the present invention, the electrolyte shortage detection unit stores a final electrolyte shortage time, which is a time when the shortage of the electrolyte is detected, in the memory unit and then resets the electrolyte-shortage time stored in the memory unit when the shortage of the electrolyte is not detected by the electrolyte shortage detection unit and a time elapsed from the final electrolyte shortage time exceeds a predetermined time.

According to the present invention, the electrolyte shortage detection, unit detects the shortage of the electrolyte by detecting a plurality of voltage values between the plurality of battery cells.

According to the present invention, the output processing unit performs output processing for attaching the time information to a difference time of the cumulative electrolyte-shortage time and outputting the difference time with the time information to the output unit, at a predetermined timing.

According to the present invention, the predetermined timing includes a regular time and an irregular time.

According to the present invention, the industrial vehicle, further comprises: a position detector that generates position information indicating a position of the industrial vehicle, wherein the output processing unit performs output processing for outputting the position information and the electrolyte-shortage time to the output unit, at the predetermined timing.

According to the present invention, a system for managing a state of an amount of electrolyte of an industrial vehicle, the system comprises: the industrial vehicle; and a management server that communicates with the industrial vehicle, wherein the output processing unit attaches the time information to the electrolyte-shortage time stored in the memory unit and outputs the electrolyte-shortage time with the time information to the management server by radio communication, at a predetermined timing.

According to the present invention, the management server includes a warning unit that sets warning levels depending on length of the electrolyte-shortage time and outputs warning according to the warning levels.

According to the present invention, an electric forklift comprises: a storage battery that includes a plurality of battery cells including electrolyte and connected in series; an electrolyte shortage detection unit that detects a shortage of the electrolyte by detecting a voltage value between the plurality of battery cells; an electrolyte-shortage time calculation unit that calculates an electrolyte-shortage time, which is a cumulative time of the shortage of the electrolyte detected by the electrolyte shortage detection unit; a memory unit that stores the electrolyte-shortage time calculated by the electrolyte-shortage time calculation unit; a time information generating unit that generates time information; and an output processing unit that performs output processing for attaching the time information to the electrolyte-shortage time stored in the memory unit and outputting the electrolyte-shortage time with the time information to an output unit, at a predetermined timing, wherein the electrolyte shortage detection unit detects the shortage of the electrolyte by detecting a plurality of voltage values between the plurality of battery cells, and the output unit transmits information, which is obtained by attaching the time information to the electrolyte-shortage time stored in the memory unit, by radio communication.

According to the invention, the electrolyte shortage detection unit detects the shortage of the electrolyte by detecting a voltage value between the plurality of battery cells of the battery that includes a plurality of battery cells including electrolyte and connected in series. Accordingly, it is possible to easily detect the shortage of the electrolyte by a simple structure. Further, the electrolyte-shortage time calculation unit calculates an electrolyte-shortage time, which is a cumulative time of the shortage of the electrolyte detected by the electrolyte shortage detection unit, and the output processing unit performs output processing for attaching the time information to the electrolyte-shortage time stored in the memory unit and outputting the electrolyte-shortage time with the time information to the output unit, at a predetermined timing. Accordingly, it is easy to manage an electrolyte-shortage time.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a left side view illustrating the entire schematic structure of a battery forklift that is an example of an industrial vehicle according to an embodiment of the invention.

FIG. **2** is a schematic diagram illustrating the entire configuration of a system for managing the state of the amount of a battery liquid of a battery forklift according to the embodiment of the invention and the electrical configuration of the battery forklift.

FIG. **3** is a flowchart illustrating the procedure of the calculation processing of a battery liquid-shortage time that is performed by a master controller.

FIG. **4** is a flowchart illustrating the procedure of the transmission processing of a battery liquid-shortage time that is performed by a communication controller.

FIG. **5** is a schematic diagram illustrating positions where the voltage of a battery is detected.

FIG. **6** is a schematic diagram illustrating the configuration of a detection circuit, when the shortage of a battery liquid of all battery cells of the battery is detected.

FIG. **7** is a schematic diagram illustrating the configuration of a detection circuit when all battery cells of the battery are grouped together and the shortage of a battery liquid is detected.

FIG. **8** is a flowchart illustrating the procedure of the calculation processing of a battery liquid-shortage time that includes the reset processing of a battery liquid-shortage time.

FIG. **9** is a flowchart illustrating the procedure of transmission processing, which is performed in the battery forklift, when the reset processing of a battery liquid shortage time is performed in a management server.

FIG. **10** is a diagram illustrating an example of the history management of a battery liquid-shortage time that is performed by the management server.

DESCRIPTION OF EMBODIMENTS

An embodiment of the invention will be described below with reference to the accompanying drawings.

(Entire Structure of Battery Forklift)

FIG. **1** is a left side view illustrating the entire schematic structure of an electric forklift (hereinafter, referred to as a battery forklift) that is an example of an industrial vehicle according to an embodiment of the invention. As illustrated in FIG. **1**, a battery forklift **1** includes a cargo handling device **3** at the front portion of a vehicle body **2**. The cargo handling device **3** includes a mast **3**_a_ and a fork **3**_b_. The fork

3*b* is guided by the mast 3*a* and moves up and down. Further, the mast 3*a* is tilted forward and rearward.

A driver's seat **4** is provided in the vicinity of the center of the vehicle body **2**. A front console **5**, a steering wheel **6**, a forward/reverse lever **7**, a lift lever **8**, and a tilt lever **9** are provided on the front side of the driver's seat **4**. Further, an accelerator pedal **10** is provided on the lower front side of the driver's seat **4**. Furthermore, a brake pedal (not illustrated) is also provided on the lower front side of the driver's seat **4**.

A battery **11** is accommodated below the driver's seat **4**. The battery **11**, which is a storage battery, is a lead storage battery, and includes thirty six 2V-battery cells that are connected in series. Each of the 2V-battery cells is filled with a predetermined amount of electrolyte. Hereinafter, the electrolyte is appropriately referred to as a battery liquid. Meanwhile, the voltage of the battery cell and the number of the battery cells are merely illustrative in this embodiment, and the invention to be described below can be applied without being limited thereto. Each of the 2V-battery cells is filled with the battery liquid. Further, a capacitor **12** is provided at the front portion of the battery **11**. Meanwhile, a lead storage battery will be described as an example of the battery in this embodiment, but the battery may be other storage batteries that need to be refilled with electrolyte due to the decrease of the amount of electrolyte.

Drive wheels **13** are provided at the front portion of the vehicle body **2**. Further, steered wheels **14** are provided at the rear portion of the vehicle body **2**. A traveling motor **15**, which is driven by the power of the battery **11** and the capacitor **12**, is connected to the drive wheels **13** through a power transmission mechanism (not illustrated). The driving of the traveling motor **15** is controlled according to the operation of the accelerator pedal **10**, the forward/reverse lever **7**, and the like. Furthermore, the steered wheels **14** are steered according to the operation of the steering wheel **6**.

A cargo handling motor **16**, which is driven by the power of the battery **11** and the capacitor **12**, is provided at the rear portion of the vehicle body **2**. The cargo handling motor **16** is connected to a hydraulic pump (not illustrated). The hydraulic pump hydraulically drives a lift cylinder and a tilt cylinder (not illustrated). When the lift lever **8** is operated, the lift cylinder expands and contracts. When the tilt lever **9** is operated, the tilt cylinder expands and contracts. The fork 3*b* moves up and down and the mast 3*a* is tilted by the expansion and contraction of the lift cylinder and the tilt cylinder.

Meanwhile, a GPS antenna **17***a* and a transmission/reception antenna **17***b* are provided at the upper portion of a cabin **17** that surrounds the driver's seat **4**. Further, a controller **20**, which controls the entire battery forklift **1**, is disposed below the driver's seat **4**.

(Outline of System and Electrical Configuration of Battery Forklift)

FIG. **2** is a schematic diagram illustrating the entire configuration of a system **100** for managing the state of the amount of the battery liquid of the battery forklift **1** according to the embodiment of the invention and the electrical configuration of the battery forklift **1**. As illustrated in FIG. **2**, the system **100** for managing the state of the amount of the battery liquid includes at least one or a plurality of battery forklifts **1** to be managed and a management server **102**, and the management server **102** is communicatively connected to the battery forklifts **1**. Accordingly, the system **100** for managing the state of the amount of the battery liquid menaces the state of shortage of the battery liquid of each of the battery forklifts **1** by using battery liquid amount-state information that is transmitted from the battery forklifts **1**. The battery forklift **1** can detect its own position on the basis of electric waves sent from a plurality of GPS satellites ST. Further, the battery forklift **1** can communicate with a base station server **101** by radio. Furthermore, the management server **102** is communicatively connected to the base station server **101** through a network NW.

The battery forklift **1** includes a GPS sensor **30** and a transceiver **31**. The GPS sensor **30** is a position detector, receives electric waves sent from the GPS satellites ST through the GPS antenna **17***a*, detects the position of the battery forklift **1**, and generates position information. Meanwhile, since time data are included in the electric waves sent from the GPS satellites ST, a time information generating unit generates time information by using the time data as described below. Further, the transceiver **31** transmits and receives information to and from the base station server **101** through the transmission/reception antenna **17***b* and a transmission/reception antenna **101***a* of the base station server **101**.

The battery forklift **1** includes the controller **20**, a key switch **32**, a DC/DO converter **33**, a cargo handling inverter **34** that drives the cargo handling motor **16**, a traveling inverter **35** that drives the traveling motor **15**, a monitor panel **36** that is disposed on the front console **5**, a charger **37**, the battery **11**, and the capacitor **12**.

The controller **20** includes a communication controller **21**, a master controller **22**, a monitor controller **23**, and an ID key controller **24**. The communication controller **21**, the master controller **22**, the monitor controller **23**, and the ID key controller **24** are communicatively connected to each other through a communication line L**1**. The controller **20** includes an output processing unit **22***c* that outputs position information, battery liquid amount-state information, time information, or the like to be described below to an output unit, such as the monitor panel **36** or the transceiver **31**. Meanwhile, the output processing unit **22***c* may be provided in the communication controller **21** or the monitor controller **23**.

The battery **11** is connected to the cargo handling inverter **34**, the traveling inverter **35**, and the DC/DC converter **33** through a power supply line L**2**, and supplies power to each of the devices. Meanwhile, the charger **37** is connected to the power supply line **72**. The DC/DC converter **33** is connected to the communication controller **21**, the master controller **22**, the monitor controller **23**, and the ID key controller **24** through a power supply line L**3**, and supplies power, which has been converted to a predetermined voltage of, for example, 24 V, to each of the controllers. Further, the key switch **32** is connected to the DC/DC converter **33**. When the key switch **32** is in a key-on state, the DC/DC converter **33** sends a key-on signal of a predetermined voltage to the communication controller **21**, the master controller **22**, the monitor controller **23**, and the ID key controller **24** through a control line L**4**, The master controller **22** is connected to the cargo handling inverter **34** and the traveling inverter **35** through a drive control line L**5**. The master controller **22** drives the cargo handling motor **16** and the traveling motor **15** by controlling the driving of the cargo handling inverter **34** and the traveling inverter **35** according to the amount of operation of the lift lever **8**, the tilt lever **9**, the steering wheel **6**, the forward/reverse lever **7**, and the accelerator pedal **10**. Meanwhile, the capacitor **12** is connected to the cargo handling inverter **34** and the traveling inverter **35**. The capacitor **12** temporarily stores or releases regenerative energy under the control of the cargo handling inverter **34** and the traveling inverter **35**. It is possible to significantly improve energy use efficiency by using the capacitor **12**.

As described above, the battery **11** includes thirty six 2V-electrode cells connected in series and outputs a voltage of 72 V, Here, a voltage detection line L**6** is provided. The voltage detection line L**6** is branched from a branch point P**1**, which is positioned between a plus terminal of a 2V-electrode cell disposed at a predetermined position and a minus terminal of the fourth 2V-electrode cell from the minus side (ground side) and of the battery **11**, and is input to the master controller **22**. The branch point. P**1** is disposed at the third position from the minus side of the battery **11** in this embodiment, but the number thereof is not limited to the third and may be other number. In the case of this embodiment, a detection voltage of the branch point P**1** (hereinafter, appropriately referred to as a battery liquid amount-detection voltage) is in the range of 0 V to 6V. When a battery liquid amount-detection voltage is equal to or lower than a predetermined threshold, the amount of the battery liquid of one or more 2V-electrode cells among three 2V-electrode cells from the minus side is decreased and a ratio of a portion of an electrode plate immersed in the electrolyte to the electrode plate is reduced as described below. When the amount of the electrolyte is decreased, the internal resistance of the 2V-electrode cell is increased and an output voltage is decreased. Accordingly, the battery liquid amount-detection voltage is decreased. When this state is detected, it is determined that the battery liquid is insufficient. The predetermined threshold is a threshold that has been determined in advance, and is set to a value of, for example, 3 V. A liquid level sensor, such as a float sensor, may be provided in each of the 2V-electrode cells inside the battery **11** in order to detect the shortage of the amount of the battery liquid of the battery **11**. However, in this embodiment, it is possible to detect the shortage of the battery liquid by a simple structure in which the voltage detection line L**6** is provided at the branch point **21** positioned outside the 2V-electrode cells.

The communication controller **21** acquires position information from the GPS sensor **30**. Further, the communication controller **21** acquires the operating state of the battery forklift **1** through the master controller **22** or the monitor controller **23** regularly or in response to an instruction from the management server **102**. The communication controller **21** further includes a clock **21***b* that forms the time information generating unit. The clock **21***b* is formed of, for example, a clock IC, and constantly generates information indicating a time. Furthermore, time data is included in the electric waves that are sent from the GPS satellites ST, and the communication controller **21** receives the time data through the GPS antenna **17***a* and the GPS sensor **30**. Further, the time measured by the clock IC and the received time data are compared with each other and the current time is corrected by a time correction program (not illustrated) that is stored in a memory **21***a* of the communication controller **21**. The time correction program forms the time information generating unit, and may be stored in a memory unit that is present in the communication controller **21** and different from the memory **21***a*. The correction of the current time, which uses the time data received from the GPS satellites ST, is performed at a predetermined interval that is set in the time correction program. Hereinafter, the current time having been subjected to correction is referred to as time information. Meanwhile, the current time, which is obtained by the clock IC, may be used as the time information as it is without correction. That is, any one of the current time that has been subjected to correction using the electric waves sent from the GPS satellites ST and the current time that is obtained from the clock IC may be used as the time information. Furthermore, the communication controller **21** transmits moving-body information, which includes an operating state, position information, time information, and a vehicle ID, to the management server **102** through the transceiver **31**. A battery liquid-shortage time that is a time when the shortage of the battery liquid of the battery **11** is detected is included in the operating state. Meanwhile, the memory **21***a* stores various kinds of information that are acquired by the communication controller **21**. The communication controller **21** transmits the time information to the management server **102** in the form of the attachment to the battery liquid-shortage time as described below, Here, the communication controller **21** may acquire time information from the time information generating unit as a time determined in advance, that is, a time indicating a transmission timing to be described below as the time information, and may transmit the time information to the management server **102** as information that has the form of the attachment to the battery liquid-shortage time.

The master controller **22** includes a battery liquid shortage detection unit **22***a*, a battery liquid-shortage time calculation unit **22***b*, and a memory **22***d*. The battery liquid shortage detection unit **22***a* determines whether or not a battery liquid amount-detection voltage input through the voltage detection line L**6** is equal to or lower than a predetermined threshold. When the battery liquid amount-detection voltage is equal to or lower than the predetermined threshold, the battery liquid shortage detection unit **22***a* detects the shortage of the battery liquid. The battery liquid-shortage time calculation unit **22***b* cumulatively adds a time at which the shortage of the battery liquid is detected. This cumulatively added battery liquid-shortage time is stored in the memory **22***d*. Since the battery liquid shortage detection unit **22***a* performs detecting processing by predetermined sampling, a predetermined sampling time is added to the battery liquid-shortage time whenever the result of the sampling result corresponds to the shortage of the battery liquid. When the acquisition of a battery liquid-shortage time is requested from the communication controller **21**, the master controller **22** outputs information, which indicates the battery liquid-shortage time, from the output processing unit **22***c* and the communication controller **21** attaches time information, which indicates the current time measured by the time information generating unit, to the battery liquid-shortage time as a timestamp and outputs the battery liquid-shortage time with the time information. That is, the time information attached to the battery liquid-shortage time, which is output to the output unit, may be a time that indicates a time at which a battery liquid-shortage time is output to the cutout unit, and may be a time that indicates a time at which the battery liquid-shortage time is further output from the output unit, for example, a transmission timing to be described below. The above-mentioned moving-body information is stored in the memory **22***d*, and the memory **22***d* is a memory in which information to be updated, such as position information or a battery liquid-shortage time, can be updated and rewritten.

The monitor controller **23** is connected to the monitor panel **36**. The monitor panel **36** is a pane including an LCD monitor and predetermined switches, a touch panel, or the like; and can input, display, and output various kinds of information. Meanwhile, the monitor panel **36** may be formed of only an LCD monitor, and may be adapted so that various kinds of information can be input, to the monitor panel **36** by separate switches or the like. The ID key controller **24** manages the IDs of operators. For example, when communication is requested from the management server **102**, operator ID information stored in the ID key controller **24** is transmitted to the management server **102** through the communication controller **21**. Alternatively, when a key is inserted into the key switch **32** or when a special operation of the monitor panel **36** is performed, authentication processing of an operator ID is performed to determine whether or not the operator is a person permitted to operate the battery forklift **1**. An ID key in which an electronic chip storing an ID is embedded can be used as the key. When the ID key controller **24** authenticates that the operator ID is an authorized ID, the ID key controller **24** transmits a signal, which indicates the result of the authentication, to the master controller **22**. As a result, the master controller **22** outputs a control signal, which allows a traveling operation or a cargo handling operation, to the DC/DC converter **33**, the cargo handling inverter **34**, or the traveling inverter **35**.

The management server **102** includes a position information database (DB) **102***a*, a map information database (DB) **102***b*, an ID information database (DB) **102***c*, a battery liquid amount-state information database (DB) **102***d*, a warning unit **102***e*, and a display unit **102***f*. The position information DB **102***a* stores the position information of the battery forklifts **1** that is transmitted from the battery forklifts **1**. The map information DB **102***b* stores map information that is necessary for the display unit **102***f* to display a place where each battery forklift **1** operates. The ID information DB **102***c* stores operator ID information. The ID information DB **102***c* may store vehicle ID information that is used to individually identify the respective battery forklifts **1**. The battery liquid amount-state information DB **102***d* stores battery liquid amount-state information that indicates whether or not the battery liquid is insufficient. The warning unit **102***e* sets gradual warning levels depending on the length of the battery liquid-shortage time, and outputs warning according to the warning levels. The output destination of the warning may be the display unit **102***f* of the management server **102** or a user terminal (not illustrated) that is connected to the management server **102**. Information, which indicates the warning, may be transmitted to the battery forklift **1** by radio and may be output by a display unit (not illustrated) of the monitor panel **36** or a sounder using a speaker (not illustrated) that is provided in the battery forklift **1**. Meanwhile, the display unit **102***f* is formed of a display device such as a liquid crystal panel.

(Calculation Processing of Battery Liquid Shortage Time)

Next, the procedure of the calculation processing of a battery liquid-shortage time, which is performed by the master controller **22**, will be described with reference to a flowchart illustrated in FIG. **3**. As illustrated in FIG. **3**, the battery liquid shortage detection unit **22***a* acquires a battery liquid amount-detection voltage through the voltage detection line L**6** by sampling that is performed at a predetermined interval (Step S**101**). After that, it is determined whether or not the battery liquid amount-detection voltage is equal to or lower than a predetermined threshold (Step S**102**).

If the battery liquid amount-detection voltage is equal to or lower than the predetermined threshold (Yes in Step S**102**), the battery liquid is insufficient. Accordingly, cumulative calculation for adding a time, which is elapsed between the previous sampling and the current sampling, that is, a sampling time to the battery liquid-shortage time stored in the memory **22***d* is performed (Step S**103**). After that, the battery liquid-shortage time stored in the memory **22***d* is updated (Step S**104**) and this processing ends. On the other hand, if the battery liquid amount-detection voltage is not equal to or lower than the predetermined threshold (No in Step S**102**), this processing ends as it is.

(Transmission Processing of Battery Liquid Shortage Time)

Next, the procedure of the transmission processing of a battery liquid-shortage time, which is performed by the communication controller **21**, will be described with reference to a flowchart illustrated in FIG. **4**. As illustrated in FIG. **4**, first, the communication controller **21** acquires a battery liquid-shortage time, which is stored in the memory **22***d* of the master controller **22**, by sampling that is performed at a predetermined interval (Step S**201**). Further, the acquired battery liquid-shortage time is stored in the memory **21***a*. Meanwhile, in Step S**201**, the communication controller **21** may acquire a battery liquid-shortage time from the memory **22***d* at a predetermined time and may acquire a battery liquid-shortage time by using the reception of a transmission request, which is requested from the management server **102**, as a trigger.

After that, it is determined whether or not the current time is a transmission timing at which moving-body information is transmitted to the management server **102** (Step S**202**). The transmission timing may be set to a regular time, such as a daily fixed time or a monthly fixed time, or an irregular time such as a time when transmission is requested from the management server **102**. When the transmission timing is a daily fixed time or a monthly fixed time, these timings are stored in a memory unit (not illustrated) or the memory **21***a* of the communication controller **21** in advance. Further, when these timings are to be changed, these timings can be changed by a change command sent from the management server **102**. If the current time is the transmission timing (Yes in Step S**202**), information (hereinafter, battery liquid amount-state information), which includes the battery liquid-shortage time, time information indicating the transmission time measured by the time information generating unit, and vehicle IDs, is transmitted to the management server **102** (Step S**203**). On the other hand, if the current time is not the transmission timing (No in Step S**202**), this processing ends as it is. However, the latest battery liquid-shortage time is stored and updated in the memory **21***a*.

Meanwhile, description has been made on the premise that the battery liquid-shortage time updated by the master controller **22** is a cumulative time. In this case, the battery liquid-shortage time transmitted by the communication controller **21** may be a difference time between the time of previous transmission and the time of the current transmission, and may be a cumulative time. It is preferable that a difference time be used in the case of the transmission of a daily fixed time and a cumulative time be used in the case of the transmission of a monthly fixed time. Further, the master controller **22** itself may store a daily difference time in the memory **22***d*, and the communication controller **21** may transmit a difference time.

(Modification of Detection of Shortage of Battery Liquid)

As illustrated in FIG. **5**, the battery liquid shortage detection unit **22***a* detects a voltage at the branch point P**1**, which is positioned between the third 2V-battery cell C**3** and the fourth 2V-battery cell C**4** from the minus side of the battery **11**, as the battery liquid amount-detection voltage in the above-mentioned embodiment. Further, for example, when the shortage of the battery liquid occurs in the 2V-battery cell C**2** as illustrated at the lower portion of FIG. **5**, the output voltage of the 2V-battery cell C**2** is decreased. The battery liquid shortage detection unit **22***a* detects the magnitude of the battery liquid amount-detection voltage in the range of 0 to 6 V, and detects the shortage of the battery liquid when the battery liquid amount-detection voltage is equal to or lower than a predetermined threshold. That is, in this embodiment, 2V-battery cells C**1** to C**3** typify all 2V-battery cells. It is advantageous in this embodiment that a voltage in the range of 0 to 6 V can be used as a detection voltage as it is.

In this modification, as illustrated in FIG. **6**, a plus-side voltage (0 to 72 V) of a 2V-battery cell C**36**, which is positioned closest to the plus side, is taken, is converted into a voltage in the range of 0 to 6 V by a voltage divider **40**, and is output to the battery liquid shortage detection unit **22***a*. Accordingly, it is possible to detect the shortage of the battery liquid in all the 2V-battery cells C**1** to C**36**.

Further, as illustrated in FIG. **7**, all the 2V-battery cells C**1** to C**36** may be organized into groups each of which includes three 2V-battery cells, and the shortage of the battery liquid of each group may be detected. It is easy to specify a 2V-battery cell in which the shortage of a battery liquid occurs, by this grouping. Meanwhile, the number of voltage detection lines L**6** in this case is twelve. Furthermore, a voltage divider needs to be provided so that a detection voltage in the range of **0** to **6** V is applied to each of the voltage detection lines except for the voltage detection line of the branch point P**1**. For example, a voltage in the range of 0 to 30 V is detected at a branch point P**11**, but a voltage divider **41** for converting this voltage range to the range of 0 to 6 V is necessary.

(Reset Processing of Battery Liquid-Shortage Time)

In the above-mentioned embodiment, the battery liquid-shortage time is transmitted to the management server **102**. Here, when an operator or the like perceives the shortage of a battery liquid and refills the battery with the battery liquid, the shortage state of the battery liquid is solved. In this case, there is a possibility that the management server **102** still recognizes the shortage of the battery liquid although the shortage of the battery liquid is solved in the battery forklift **1**. For this reason, when a predetermined time has passed after the shortage of the battery liquid is detected, in this modification, it is regarded as that the battery is refilled with a battery liquid and the battery liquid-shortage time having been kept is reset.

FIG. **8** is a flowchart illustrating the procedure of the calculation processing of a battery liquid-shortage time that includes the reset processing of a battery liquid-shortage time. As illustrated in FIG. **8**, the battery liquid shortage detection unit **22***a* acquires a battery liquid amount-detection voltage through the voltage detection line L**6** by sampling that is performed at a predetermined interval and acquires time information, which indicates the current time, from the time information generating unit (Step S**301**). After that, it is determined that the battery liquid amount-detection voltage is equal to or lower than a predetermined threshold (Step S**302**).

If the battery liquid amount-detection voltage is equal to or lower than the predetermined threshold (Yes in Step S**302**), the battery liquid is insufficient. Accordingly, cumulative calculation for adding a time, which is elapsed between the previous sampling and the current sampling, that is, a sampling time to the battery liquid-shortage time stored in the memory **22***d* is performed (Step S**303**). Further, the current time acquired in Step S**301** is set to a final battery liquid shortage time (Step S**304**). After that, the battery liquid-shortage time stored in the memory **22***d* and the final, battery liquid shortage time are updated (Step S**305**), and then this processing ends.

On the other hand, if the battery liquid amount-detection voltage is not equal to or lower than the predetermined threshold (No in Step S**302**), it is further determined whether or not a time elapsed from the final battery liquid shortage time having been recently updated exceeds a predetermined time (Step S**306**). If the elapsed time exceeds the predetermined time (Yes in Step S**306**), it is regarded as that the battery is already refilled with a battery liquid, processing for resetting the battery liquid-shortage time stored in the memory **22***d* is performed (Step S**307**), and this processing ends. On the other hand, if the elapsed time does not exceed the predetermined time (No in Step S**306**), this processing ends as it is. Meanwhile, after Step S**307**, a battery-normality signal may be generated in conjunction with the reset processing and may be transmitted to the management server **102** as one of operating states. The battery-normality signal is a signal indicating that the shortage of the battery liquid of the battery **11** has been solved. When the management server **10** receives this signal, an operator of the management server **102**, for example, a person performing the maintenance of the battery forklifts **1** can definitely grasp that the shortage of the battery liquid of the battery forklift **1** in which the shortage of the battery liquid has occurred is solved. Meanwhile, if the battery-normality signal and the time information measured by the time information generating unit are linked to each other and transmitted to the management server **102**, it is possible to grasp when the shortage of the battery liquid has been solved. This time information indicates a time at which moving-body information such as an operating state is transmitted to the management, server **10**, but may indicate a time at which the battery liquid-shortage time is output to the output unit, such as the monitor panel **36** or the transmission/reception unit **31** as described above.

Meanwhile, the above-mentioned reset processing is performed in the battery forklift **1**, but may be performed in the management server **102**. In this case, the battery forklift **1** transmits battery liquid amount-state information, which includes the final battery liquid shortage time, to the management server **102**.

That is, as illustrated in FIG. **9**, first, the communication controller **21** acquires a battery liquid-shortage time, which is stored in the memory **22***d* of the master controller **22**, and the final battery liquid shortage time by sampling that is performed at a predetermined interval (Step S**401**). Further, the acquired battery liquid-shortage time and the acquired final battery liquid shortage time are stored in the memory **21***a*.

After that, it is determined whether or not the current time is a transmission timing at which moving-body information is transmitted to the management server **102** (Step S**402**). If the current time is the transmission timing (Yes in Step S**402**), battery liquid amount-state information, which includes the battery liquid-shortage time, the final battery liquid shortage time, time information indicating the transmission time, and vehicle IDs, is transmitted to the management server **102** (Step S**403**). On the other hand, if the current time is not the transmission timing (No in Step S**402**), this processing ends as it is. Accordingly, even though the reset processing is not performed in the battery forklift **1**, it is possible to perform the processing for resetting the battery liquid-shortage time in the management server **102**.

(Management Processing of Management Server)

Since the management server **102** can obtain the above-mentioned battery liquid-shortage time from each of the battery forklifts **1**, the management server **102** can quickly warn an operator or a person who performs maintenance. Further, since the management server **102** can obtain time information, such as a transmission time, attached to a battery liquid-shortage time, the management server **102** can manage the history of the battery liquid-shortage time of each of the battery forklifts **1** as illustrated in FIG. **10**. Furthermore, each of the battery forklifts **1** can acquire position information by the GPS sensor **30** as described above, and can transmit the obtained position information to the management server **102** at the timing of Step S**202** of FIG. **4** or Step S**402** of FIG. **9**. That is, the position information and the vehicle IDs included in the battery liquid amount-state information are linked and stored in the management server **102**. A person performing the maintenance of the battery forklifts **1** can know a period in which the shortage of the battery liquid is likely to occur or can know a place in which a battery forklift **1** showing the shortage of the battery liquid operates, and can check a way to cope with the shortage of the battery liquid or a maintenance plan for the refill of the battery liquid, by managing and analyzing the history of the battery liquid-shortage time. Moreover, a battery forklift of which the battery liquid is insufficient can be displayed and output on a map of the display unit **102***f* by using a predetermined design or the like so as to be superimposed. Accordingly, it is possible to definitely grasp whether the battery liquid of a battery forklift **1** operating at a certain place is insufficient. Further, if a place in which the shortage of the battery liquid frequently occurs can be specified, it is also possible to estimate that a battery forklift **1** operating at the place is frequently charged and discharged. According to the above-mentioned system **100** for managing the state of the amount of the battery liquid, it is possible to appropriately refill the battery with a battery liquid and to perform the check of a plan for the replacement of the battery **11** itself, the planned preparation of new batteries **11**, and the like.

Further, since the management server **102** can obtain vehicle IDs, the management server **102** can easily manage the shortage state of the battery liquid or the battery state of each of the battery forklifts even though a plurality of same types of vehicles are present in the same region. For example, the battery states of a plurality of battery forklifts can be collectively managed by a person who needs to monitor the plurality of battery forklifts operating in a factory. The vehicle IDs may correspond to the unique serial numbers of the respective forklifts **1**, and may be the serial number or the like of the communication controller **21**. That is, the vehicle IDs only have to individually identify the respective forklifts.

Meanwhile, in the above-mentioned embodiment, the battery liquid shortage detection unit **22***a* detects the shortage of the battery liquid when the battery liquid amount-detection voltage is equal to or lower than a predetermined threshold. However, the invention is not limited thereto. A battery liquid amount-detection voltage may be divided into two stages, and a battery liquid amount-detection voltage of the first stage may be set to, for example, 3 V or less. When the battery liquid amount-detection voltage is 3 V or less, the battery liquid shortage detection unit **22***a* may detect the shortage of the battery liquid. The range of a battery liquid amount-detection voltage of the second stage may be set to be, for example, higher than 3 V and 4 V or less. When the battery liquid amount-detection voltage is in that range, the battery liquid shortage detection unit **22***a* may output a signal detecting that the amount of the battery liquid tends to decrease. It is possible to finely manage the shortage state of the battery liquid by detecting the degree of the shortage state of the battery liquid in two stages as described above.

Further, the communication controller **21** and the master controller **22** are formed as separate controllers in the above-mentioned embodiment, but the communication controller may be provided in the master controller **22**.

Furthermore, various kinds of information may be transmitted to the management server **102** as information on the battery **11** other than the battery liquid amount-state information including the battery liquid-shortage time or the final battery liquid shortage time. For example, whenever charging is performed, information indicating the charging time and charged electric energy of the battery **11** is obtained by a sensor or the like provided in the battery forklift **1** and these kinds of information may be transmitted to the management server **102** together.

Further, the above-mentioned embodiment is based on the premise that information on a battery liquid-shortage time and the like is transmitted to the management server **102**, but the invention is not limited thereto. These kinds of information may be transmitted to the monitor panel **36** of the battery forklift **1** without using a communication system, and may be displayed on a display unit (not illustrated) of the monitor panel **36**. Even in this case, the controller **20** attaches time information, which indicates the current time measured by the time information generating unit, to a battery liquid-shortage time as a timestamp, and outputs the battery liquid-shortage time with the time in to the monitor panel **36** through the monitor controller **23**. A mountainous region or a region in which radio communication facilities are not provided is a region in which radio communication is not available. In the case of a forklift **1** operating in such a place, when an operator or a person performing maintenance sees information indicating a battery liquid-shortage time or time information which is displayed on the monitor panel **36**, the operator or the person can recognize the shortage of the battery liquid.

Moreover, description has been made in the above-mentioned embodiment on the premise that the battery **11** and the capacitor **12** are used, but the invention is also applied to a battery forklift that is driven only by the battery **11** without the capacitor **12**. Further, the battery forklift **1** is an example of an industrial vehicle as described above and this embodiment can be applied generally to an industrial vehicle. For example, this embodiment is also applied to an electric construction machine that is configured to drive an electric motor by using a battery as a power source without an engine, to drive a hydraulic pump by the electric motor to supply a working fluid to a hydraulic cylinder of a working machine, and to operate the working machine.

REFERENCE SIGNS LIST

1 BATTERY FORKLIFT
2 VEHICLE BODY
3*b* FORK
3*a* MAST
3 CARGO HANDLING DEVICE
4 DRIVER'S SEAT
5 FRONT CONSOLE
6 STEERING WHEEL
7 FORWARD/REVERSE LEVER
8 LIFT LEVER
9 TILT LEVER
10 ACCELERATOR PEDAL
11 BATTERY
12 CAPACITOR

13 DRIVE WHEEL
14 STEERED WHEEL
15 TRAVELING MOTOR
16 CARGO HANDLING MOTOR
17 CABIN
17*a* GPS ANTENNA
17*b* TRANSMISSION/RECEPTION ANTENNA
20 CONTROLLER
21 COMMUNICATION CONTROLLER
21*a*, **22***d* MEMORY
21*b* CLOCK
22 MASTER CONTROLLER
22*a* BATTERY LIQUID SHORTAGE DETECTION UNIT
22*b* BATTERY LIQUID-SHORTAGE TIME CALCULATION UNIT
22*c* OUTPUT PROCESSING UNIT
23 MONITOR CONTROLLER
24 ID KEY CONTROLLER
30 GPS SENSOR
31 TRANSCEIVER
32 KEY SWITCH
33 DC/DC CONVERTER
34 CARGO HANDLING INVERTER
35 TRAVELING INVERTER
36 MONITOR PANEL
37 CHARGER
40, **41** VOLTAGE DIVIDER
100 SYSTEM FOR MANAGING STATE OF THE AMOUNT OF BATTERY LIQUID
101 BASE STATION SERVER
101*a* TRANSMISSION/RECEPTION ANTENNA
102 MANAGEMENT SERVER
102*a* POSITION INFORMATION DATABASE
102*b* MAP INFORMATION DATABASE
102*c* ID INFORMATION DATABASE
102*d* BATTERY LIQUID AMOUNT-STATE INFORMATION DATABASE
102*e* WARNING UNIT
102*f* DISPLAY UNIT
L**1** COMMUNICATION LINE
L**2** POWER SUPPLY LINE
L**3** POWER SUPPLY LINE
L**4** CONTROL LINE
L**5** DRIVE CONTROL LINE
L**6** VOLTAGE DETECTION LINE
C**1** to C**36** 2V-BATTERY CELL
P**1**, P**11** BRANCH POINT
NW NETWORK
ST GPS SATELLITE

The invention claimed is:

1. An industrial vehicle comprising:

a storage battery that includes a plurality of battery cells including electrolyte and electrode plates, the battery cells being connected in series, and a detecting point, disposed between the electrode plates of adjacent battery cells, at which a voltage value for detecting a shortage of the electrolyte is detected;

an electrolyte shortage detection unit that detects a shortage of the electrolyte in at least one of the battery cells by detecting a voltage value at the detecting point;

an electrolyte-shortage time calculation unit that calculates an electrolyte-shortage time, which is a cumulative time of the shortage of the electrolyte detected by the electrolyte shortage detection unit when the shortage of the electrolyte continues;

a memory unit that stores the electrolyte-shortage time calculated by the electrolyte-shortage time calculation unit;

a time information generating unit that generates time information; and an output processing unit that performs output processing for attaching the time information to the electrolyte-shortage time stored in the memory unit and outputting the electrolyte-shortage time with the time information to an output unit, at a predetermined timing.

2. The industrial vehicle according to claim **1**,

wherein the electrolyte shortage detection unit stores a final electrolyte shortage time, which is a time when the shortage of the electrolyte is detected, in the memory unit and then resets the electrolyte-shortage time stored in the memory unit when the shortage of the electrolyte is not detected by the electrolyte shortage detection unit and a time elapsed from the final electrolyte shortage time exceeds a predetermined time.

3. The industrial vehicle according to claim **1**,

wherein the electrolyte shortage detection unit includes a plurality of detecting points, disposed between adjacent battery cells, at each of which a voltage value for detecting a shortage of the electrolyte is detected, and detects the shortage of the electrolyte by detecting a plurality of voltage values between the plurality of battery cells.

4. The industrial vehicle according to claim **1**,

wherein the output processing unit performs output processing for attaching the time information to a difference time of the cumulative electrolyte-shortage time and outputting the difference time with the time information to the output unit, at a predetermined timing.

5. The industrial vehicle according to claim **1**,

wherein the predetermined timing includes a regular time and an irregular time.

6. The industrial vehicle according to claim **1**, further comprising:

a position detector that generates position information indicating a position of the industrial vehicle,

wherein the output processing unit performs output processing for outputting the position information and the electrolyte-shortage time to the output unit, at the predetermined timing.

7. A system for managing a state of an amount of electrolyte of an industrial vehicle, the system comprising:

an industrial vehicle including:

a storage battery that includes a plurality of battery cells including electrolyte and electrode plates, the battery cells being connected in series, and a detecting point, disposed between the electrode plates of adjacent battery cells, at which a voltage value for detecting a shortage of the electrolyte is detected;

an electrolyte shortage detection unit that detects a shortage of the electrolyte in at least one of the battery cells by detecting a voltage value at the detecting point;

an electrolyte-shortage time calculation unit that calculates an electrolyte-shortage time, which is a cumulative time of the shortage of the electrolyte detected by the electrolyte shortage detection unit when the shortage of the electrolyte continues;

a memory unit that stores the electrolyte-shortage time calculated by the electrolyte-shortage time calculation unit;

a time information generating unit that generates time information; and an output processing unit that performs output processing for attaching the time information to the electrolyte-shortage time stored in the memory unit and outputting the electrolyte-shortage time with the time information to an output unit, at a predetermined timing; and

a management server that communicates with the industrial vehicle,

wherein the output processing unit attaches the time information to the electrolyte-shortage time stored in the memory unit and outputs the electrolyte-shortage time with the time information to the management server by radio communication, at a predetermined timing.

8. The system according to claim **7**,

wherein the management server includes a warning unit that sets warning levels depending on length of the electrolyte-shortage time and outputs warning according to the warning levels.

9. An electric forklift comprising:

a storage battery that includes a plurality of battery cells including electrolyte and electrode plates, the battery cells being connected in series, and a detecting point, disposed between the electrode plates of adjacent battery cells, at which a voltage value for detecting a shortage of the electrolyte is detected;

an electrolyte shortage detection unit that detects a shortage of the electrolyte in at least one of the battery cells by detecting a voltage value at the detecting point;

an electrolyte-shortage time calculation unit that calculates an electrolyte-shortage time, which is a cumulative time of the shortage of the electrolyte detected by the electrolyte shortage detection unit when the shortage of the electrolyte continues;

a memory unit that stores the electrolyte-shortage time calculated by the electrolyte-shortage time calculation unit;

a time information generating unit that generates time information; and

an output processing unit that performs output processing for attaching the time information to the electrolyte-shortage time stored in the memory unit and outputting the electrolyte-shortage time with the time information to an output unit, at a predetermined timing,

wherein the electrolyte shortage detection unit detects the shortage of the electrolyte by detecting a plurality of voltage values between the plurality of battery cells, and

the output unit transmits information, which is obtained by attaching the time information to the electrolyte-shortage time stored in the memory unit, by radio communication.

10. An industrial vehicle comprising:

a storage battery that includes a plurality of battery cells including electrolyte and electrode plates, the battery cells being connected in series, and a detecting point, disposed between the electrode plates of adjacent battery cells, at which a voltage value for detecting a shortage of the electrolyte is detected;

an electrolyte shortage detection unit that detects a shortage of the electrolyte by detecting a voltage value between the plurality of battery cells;

an electrolyte-shortage time calculation unit that calculates an electrolyte-shortage time, which is a cumulative time of the shortage of the electrolyte detected by the electrolyte shortage detection unit when the shortage of the electrolyte continues;

a memory unit that stores the electrolyte-shortage time calculated by the electrolyte-shortage time calculation unit;

a time information generating unit that generates time information; and

an output processing unit that performs output processing for attaching the time information to the electrolyte-shortage time stored in the memory unit and outputting the electrolyte-shortage time with the time information to an output unit, at a predetermined timing,

wherein the electrolyte shortage detection unit stores a final electrolyte shortage time, which is a time when the shortage of the electrolyte is detected, in the memory unit and then resets the electrolyte-shortage time stored in the memory unit when the shortage of the electrolyte is not detected by the electrolyte shortage detection unit and a time elapsed from the final electrolyte shortage time exceeds a predetermined time.

11. The industrial vehicle according to claim **10**, wherein the electrolyte shortage detection unit detects the shortage of the electrolyte by detecting a plurality of voltage values between the plurality of battery cells.

12. The industrial vehicle according to claim **10**, wherein the output processing unit performs output processing for attaching the time information to a difference time of the cumulative electrolyte-shortage time and outputting the difference time with the time information to the output unit, at a predetermined timing.

13. The industrial vehicle according to claim **10**, wherein the predetermined timing includes a regular time and an irregular time.

14. The industrial vehicle according to claim **10**, further comprising:

a position detector that generates position information indicating a position of the industrial vehicle,

wherein the output processing unit performs output processing for outputting the position information and the electrolyte-shortage time to the output unit, at the predetermined timing.

15. A system for managing a state of an amount of electrolyte of an industrial vehicle, the system comprising:

an industrial vehicle including:

a storage battery that includes a plurality of battery cells including electrolyte and electrode plates, the battery cells being connected in series, and a detecting point, disposed between the electrode plates of adjacent battery cells, at which a voltage value for detecting a shortage of the electrolyte is detected;

an electrolyte shortage detection unit that detects a shortage of the electrolyte by detecting a voltage value between the plurality of battery cells;

an electrolyte-shortage time calculation unit that calculates an electrolyte-shortage time, which is a cumulative time of the shortage of the electrolyte detected by the electrolyte shortage detection unit when the shortage of the electrolyte continues;

a memory unit that stores the electrolyte-shortage time calculated by the electrolyte-shortage time calculation unit;

a time information generating unit that generates time information; and

an output processing unit that performs output processing for attaching the time information to the electrolyte-shortage time stored in the memory unit and outputting the electrolyte-shortage time with the time information to an output unit, at a predetermined timing; and a management server that communicates with the industrial vehicle,

wherein the electrolyte shortage detection unit stores a final electrolyte shortage time, which is a time when the shortage of the electrolyte is detected, in the memory unit and then resets the electrolyte-shortage time stored in the memory unit when the shortage of the electrolyte is not detected by the electrolyte shortage detection unit and a time elapsed from the final electrolyte shortage time exceeds a predetermined time, and

wherein the output processing unit attaches the time information to the electrolyte-shortage time stored in the memory unit and outputs the electrolyte-shortage time with the time information to the management server by radio communication, at a predetermined timing.

16. The system according to claim **15**, wherein the management server includes a warning unit that sets warning levels depending on length of the electrolyte-shortage time and outputs warning according to the warning levels.

17. An electric forklift comprising:

a storage battery that includes a plurality of battery cells including electrolyte and connected in series;

an electrolyte shortage detection unit that detects a shortage of the electrolyte by detecting a voltage value between the plurality of battery cells;

an electrolyte-shortage time calculation unit that calculates an electrolyte-shortage time, which is a cumulative time of the shortage of the electrolyte detected by the electrolyte shortage detection unit;

a memory unit that stores the electrolyte-shortage time calculated by the electrolyte-shortage time calculation unit;

a time information generating unit that generates time information; and

an output processing unit that performs output processing for attaching the time information to the electrolyte-shortage time stored in the memory unit and outputting the electrolyte-shortage time with the time information to an output unit, at a predetermined timing,

wherein the electrolyte shortage detection unit detects the shortage of the electrolyte by detecting a plurality of voltage values between the plurality of battery cells,

the output unit transmits information, which is obtained by attaching the time information to the electrolyte-shortage time stored in the memory unit, by radio communication, and

the electrolyte shortage detection unit stores a final electrolyte shortage time, which is a time when the shortage of the electrolyte is detected, in the memory unit and then resets the electrolyte-shortage time stored in the memory unit when the shortage of the electrolyte is not detected by the electrolyte shortage detection unit and a time elapsed from the final electrolyte shortage time exceeds a predetermined time.

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